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# THE EPHEMERIDES
## Application for Computers and Instruments

The definition of ephemeris is a table giving the coordinates of one or a number of celestial bodies at a number of specific times during a given period; also a publication that presents a collection of such tables. The following contains information and comments of five ephemerides.

## BLM EPHEMERIS

The BLM ephemeris was available for many years. It was designed for direct altitude observations on the sun and was convenient for preparing the declination chart for solar transit units. It was convenient for hour angle observations on polaris and the azimuth at elongation could be determined with little or no calculations. Accurate time at elongation was not critical. The selected stars were primarily used for altitude observations for azimuth. The time of transit was tabulated to one-tenth of a minute, which would translate to an accuracy not to exceed 3 seconds of time. This is too much error for hour angle observations. This ephemeris does not suffice for todays methods of azimuth determination.

## LIETZ EPHEMERIS

The Lietz ephemeris has a good tabulation of data for the sun and polaris. It is too restrictive for the number of selected stars; positions for only eight stars are listed. The data is easy to use and requires data input (but not excessive). The computer programs listed in this ephemeris does not compute the vertical or zenith angles. The vertical angle must be observed and compared to the computed value to at least partially verify the data input is correct. The user of this ephemeris would probably write their own programs.

## NAUTICAL ALMANAC

The nautical almanac is a more complete ephemeris. It has data pertaining to the four navigational planets and the moon. Numerous stars are listed and the data input is nearly equivalent with the Lietz Ephemeris. A user must write their own programs or use programs written by others. This is a very good ephemeris, easy to use, and does have the planets and moon. Hour angle observations on the moon may be used to an advantage, as no vertical angles are required for azimuth.

attachment 2

## THE COMPUTERS ALMANAC

The computers almanac tabulates data from constants for computer application. This data is entered yearly and consumes much storage space. A user could be selective on which celestial bodies to be entered into storage. Constants for the moon would be changed monthly. The computers Almanac is a good choice. There is a possibility another computer would be carried on line for this purpose. Programs could be written to supply all or most ephemeral data.

## THE ASTRO*ROM

The Astro*Rom and users manual is a self contained ephemeris with data from 1965 to 2010. It computes azimuth and vertical angles to various celestial bodies with little data input. Many options are written into the program for the various techniques of observations. It has a very limited number of star coordinates, eight at the present time. More star coordinates may be obtained. The sun, polaris, and selected stars are the only ones programed. This is the most ideal system of any of the ephemerides.

## ADDITIONAL INFORMATION

For additional information and comparisons refer to the attachment.

## ASTRONOMY

Surveying is dependent upon certain principles of astronomy. Astronomy relates to positions, magnitude, and motion of celestial bodies. It is considered the oldest of the sciences and the term is derived from compounding of two Greek words, "astron" meaning a star or constellation, and "nomos" or law. The literal translation is "law of the stars".

Additional data may be obtained from the ephemerides by mathematical applications of basic principles. This application has been partially explained and illustrated in the paper "astro-aid".

## COMPUTER APPLICATION

There is a certain and limited amount of storage capabilities in computers. Only so many ports are available for read only memory or extended memory modules. How computers are used on a project or consideration of an extra computer for astronomy should not be ruled out. It may be cost effective.

attachment 2-2

## INSTRUMENT APPLICATION

For day time observations of stars and planets a telescope with 25 to 32 power is ideal. The higher power of eye-pieces, such as the Wild 41 strongly magnifies the particles in the earths atmosphere and may blot out the dimmer stars. Higher power does not necessarily mean better observing. The Roelofs prism is ideal for the sun observations. The solar circle is good, especially for the moon. Other filters offer capabilities for solar observations also. An edge, either leading or trailing may be observed depending on the retical and the computer programs. Measuring the altitude and comparing it with the computed altitude would or could detect error in data input.

The type and requirements of a survey would probably determine the astronomy techniques. Utilizing the hour angle method, the moon could be used for certain times and projects. At least it could be used to orient the observer for the planets or stars observations.

## SUMMARY

The equipment necessary to utilize survey astronomy should be available to a survey party as with any other tool. The application and skills necessary for celestial observations is easily taught to an instrument operator. One ephemeris or one computer program for all surveying activities is impractical. The BLM ephemeris was too restrictive and there is no apparent need to consider it. The availability of the equipment is the responsibility of the surveyor and cadastral management. When to use this "tool" requires judgement and knowledge by the surveyor. Reasonable accuracy at a reasonable cost is paramount.

Attachment 2-3

(attachment) CHARTS

The following charts depict the comparison of capabilities of the various ephemerides in the hour angle and altitude methods of observations for azimuth.

METHOD REQUIREMENTS

| | | | |
|---|---|---|---|
| Hour Angle | Lat. | Long. | Accurate time |
| Altitude | Lat. | | |

| EPHEMERIDES | SUN | MOON | POLARIS | STARS | VENUS | JUPITER | MARS | SATURN |
|---|---|---|---|---|---|---|---|---|

### HOUR ANGLE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BLM | X | | X | | | | | |
| LIETZ | X | | X | (8) X | | | | |
| NAUTICAL ALMANAC | X | X | X | X | X | X | X | X |
| COMPUTERS ALMANAC | X | X | X | X | X | X | X | X |
| ASTRO*ROM | X | | X | (8+) X | | | | |

### ALTITUDE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BLM | X | | | X | | | | |
| LIETZ | X | | | X | | | | |
| NAUTICAL ALMANAC | X | X a. | | X | X a. | X a. | X a. | X a. |
| COMPUTERS ALMANAC | X | X a. | | X | X a. | X a. | X a. | X a. |
| ASTRO*ROM | | | | | | | | |

a. Not ideal for "Altitude Method"

attachment 2-4